NOAA SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP)

PROJECT Final REPORT

PROJECT TITLE:
Climate Adaptation Planning for Small and Medium Water Systems: Case Study of Lompoc Valley

INVESTIGATORS *(Research team and full contact information):*

GEI Consultants, Inc.
Kwabena Oduro Asante (PI), kasante@geiconsultants.com, Tel. (916) 631-4573
Robert Almy (Co- PI, Independent Consultant), ralmy3@yahoo.com , Tel. (805) 448-6815
Pradnya Khimsara, Hydrologist, pkhimsara@geiconsultants.com, Tel. (916) 631-4535
GEI Consultants, Inc.
2868 Prospect Park Drive Suite 400
Rancho Cordova, CA 95670

Vandenberg Village Community Services District
Joseph Barget, General Manager, JBarget@vvcsd.org, Tel. (805) 733-2475
Cynthia Allen, Office Manager, callen@vvcsd.org, Tel. (805) 733-2475
3757 Constellation Road
Vandenberg Village
Lompoc, CA 93436

Mission Hills Community Services District
Michael Riley, General Manager, mr@mhcsd.org, Tel. (805) 733-4366
150 E Burton Mesa Blvd.
Lompoc, CA 93436

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PROJECT YEARS: 08/01/2012 - 07/31/2014

TIME PERIOD ADDRESSED BY REPORT: August 2012 – July 2014

I. PRELIMINARY MATERIALS

A. Research project objective

About 97% of water systems in the United States can be classified as small or medium water systems. These water systems rely heavily on local water supplies; have fewer paying customers, and are limited in monetary resources. They also have limited access to imported water supply. Small changes in their local water resources can have major impacts on the water systems, thus making them vulnerable to climate change. Many of these systems are due for upgrades in the coming years. These capital improvement processes provide an opportunity to incorporate climate change analysis in the plans. The objective of this project is to develop a set of guidelines and tools to assist water managers for these systems to conduct climate analysis without expending too many resources. The research team attained this objective by conducting a two-step case study in the Lompoc Valley located in Santa Barbara, California. The first step involved identifying climate indices indicative of the state of water resources in the region. The second step involved building and testing a framework to transfer the information from these climate indices to decision making for infrastructure elements by engagement of stakeholders and regional experts. The technical team is now in the process of creating adaptation plans for the communities studied and packaging the tools developed to help other water systems conduct climate analysis for their water systems. 'Lessons learnt' during the course of the process and 'Recommendations' for enhancements in NOAA's data products to match needs of small water systems are also being prepared by the technical team.

B. Stakeholders and decision makers

- Board of Directors of Vandenberg Village Community Services District
- Board of Directors of Mission Hills Community Services District
- Joseph Barget, General Manager, Vandenberg Village Community Services District
- Michael Riley, General Manager, Mission Hills Community Services District
- Susan Segovia, Senior Administrative Analyst, Utility Department, City of Lompoc
- Bruce Wales, General Manager, Santa Ynez River Water Conservation District
- Matt Naftaly, Water Agency Manager, Santa Barbara County Water Agency
- Fray Crease, Storm Water Quality Manager, Santa Barbara County Water Agency
- Michael Anderson, California State Climatologist, California Department of Water Resources
- Residents of Vandenberg Village
- Residents of Mission Hills
- Residents of the City of Lompoc

C. Approach

The study has been conducted in a two-step process. The first step involved understanding the nature of water resources and climate and their relationship in the study area using historical data. Potential climate indices indicative of water supply and demand in the region were also classified during this process. This step provided for the development of useful soft monitoring tools to recognize near-future threats and techniques to identify long term relationships between climate indices and decision variables such as water demand and supply for water systems. These relationships were then

used to project and set decision variables goals using changes in climate indices obtained from predictions from NOAA and other sources. The research team also conducted stakeholder meetings to inform them of research results.

The next step undertaken was to identify water resource focus areas which could be impacted directly by climate change or indirectly through changing ecosystems or human responses. The focus areas were split into sub-categories, and a questionnaire was prepared to help quantify vulnerabilities within each sub-categories. A comprehensive list of project options was also created to facilitate selection of local projects to alleviate vulnerabilities. Workshops are being conducted with water professionals and planners to perform vulnerability assessments and to prepare an adaptation plan with proposed projects and implementation strategy. The research team is also packaging and making available the forms and tools developed for use by other water systems. A public workshop is also being planned to present community members with the climate analysis and adaptation plan.

D. Matching funds/activities

E. Partners

- NOAA Sectoral Applications Research Program (SARP)
- Vandenberg Village Community Services District
- Mission Hills Community Services District
- The City of Lompoc
- Santa Ynez River Water Conservation District
- Santa Barbara County Water Agency
- California Department of Water Resources

II. ACCOMPLISHMENTS *(Information in this section should be updated annually)*

A. Project timeline and tasks accomplished *(Can be submitted in bullet form – limit of 2 pages)*

Developed a Climate Adaptation Planning Toolkit for Small Water Systems consisting of the following components:

- Climate Change Assessment Template

  A template has been developed for presenting the results of climate change analysis. It includes tables for reporting baseline water system characteristics, historical changes in local climate, future climate change projections, and applicability of derived climate Indices for monitoring changes in the water system.

- Infrastructure Vulnerability Assessment Worksheet

  A worksheet has been developed for assessing the vulnerability of water infrastructure. Water system vulnerabilities are broken down into 6 major groups including water supply, water demand, water quality, ecosystem change, flooding and regulatory challenges. Under each major group, a set of challenges are identified along with a set of questions to consider when

determining whether a challenge is relevant to the study area or not. A priority rating is assigned to each challenge after considering answers to the set of related questions.

- Tools for Assembling a Portfolio of Adaptation Projects

A set of look up tables have been developed to enable water planners to identify and project actions which if implemented would reduce climate vulnerabilities and improve infrastructure resilience. In addition, a database of over 100 adaptation project ideas has been assembled from water sector planning documents in California to facilitate building of project portfolios for addressing climate vulnerabilities.

B. Application of your findings to inform decision making

Applied the NOAA SARP Climate Adaptation Planning Toolkit for Small Water Systems to the development of a climate adaptation plan for the Lompoc Area Water Purveyors including

- Assembling climate datasets and performing climate change analysis. Presenting results of the climate change analysis to water managers from the three small water systems and cooperators from surrounding communities and regional agencies. Water managers and cooperators attended session and were actively engaged in sessions to learn about local climate changes and variability, and its impacts on local water resources.
- Performing vulnerability assessment for the Lompoc Area by conducting a workshop with a panel of local water managers, regional cooperators, and consultants. The panel reviewed each projected water related climate change impact, assigned a vulnerability rating and discussed results with other panel members to understanding each other's rational for assign a ranking. The final rankings therefore reflect the combined priorities of the collaborating agencies, given both common information on each vulnerability and differences in priorities of each agency.
- Engaging separately with each agency to provide specific feedback on the results and providing with an opportunity to identify adaptation projects which can help to alleviate the vulnerabilities identified for their water system. The project roster and infrastructure evaluation questionnaire are used to negotiate a set of collaborative projects to improve the resilience of all three water systems to climate change impacts.
- Documenting the results in an adaptation plan, the contents of which will be integrated and implemented through other State-mandated planning processes.
- Conducting a community outreach workshop to present the analysis and adaptation plan.

B. Planned methods to transfer

- Transferred to Lompoc area decision makers through workshops including
  - January 2013 presentation at the joint meeting of the Boards of Directors of Vandenberg, and Mission Hills Community Service Districts

        - December 2013 Climate analysis workshop held at Vandenberg Village CSD
        - February 2014 Vulnerability assessment and infrastructure planning workshop held at Mission Hills CSD
        - June 2014 community outreach workshop held at the City of Lompoc Council Chambers.
    - Outreach to the scientific and engineering communities through presentations at
        - December 2013 Fall Meeting of American Geophysical Union
        - March 2014 Sustainability Conference of the American Water Works Association
        - October 2014 Annual Conference of the Groundwater Resources Association of California
    - Dissemination of the Climate Adaptation Planning Toolkit for Small Water Systems by
        - Making it available online through the project website
        - Submission as a planning tool for inclusion in the 2015 National Adaptation Conference and subsequently to the Climate Adaptation Knowledge Exchange (www.cakex.org).

D. Significant deviations from proposed work plan anticipated

E. Completed publications, white papers, or reports (with internet links if possible).

Asante, K.O., Almy, R. and Khimsara, P. 2014, NOAA SARP Climate Adaptation Planning Toolkit for Small Water Systems. Prepared by GEI Consultants, Rancho Cordova, California. (Climate Analysis Toolkit)

Asante, K. O., Khimsara, P. and Almy, R. 2014, Preparing Local Groundwater Systems for Climate Variability and Change, Abstract 4A-4, presented at 2014 Annual Conference of the Groundwater Resources Association of California, Sacramento, CA, 16 Oct. (Abstract)

Asante, K.O., Almy, R. and Khimsara, P. 2014, NOAA SARP Climate Adaptation Planning Toolkit for Small Water Systems. Prepared by GEI Consultants, Rancho Cordova, California. (Toolkit).

Asante, K. O., Khimsara, P. and Almy, R. 2014, Preparing Local Groundwater Systems for Climate Variability and Change, Abstract 4A-4, presented at 2014 Annual Conference of the Groundwater Resources Association of California, Sacramento, CA, 16 Oct. (Abstract).

Khimsara, P., Almy, R. & Asante, K. O. 2014. Climate Change Analysis for Small and Medium Water Systems, Abstract TUE 03-02, presented at 2014 Sustainable Water Management Conference, AWWA, Denver, CO, 30 Mar -2 Apr. (Abstract)

Asante, K. O., Khimsara, P. & Chan, A. 2013. Data Sparsity Considerations in Climate Impact Analysis for the Water Sector (Invited), Abstract H52C-05 presented at 2013 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec.(Abstract) (Presentation)

Asante, K. O., Khimsara, P. & Brown, K. 2013. Applying Climate Science to Urban Water Infrastructure Planning in California, Abstract H12F-03 presented at 2013 Fall Meeting, AGU, San Francisco, CA, 9-13 Dec. (Abstract) (Presentation)

Abstract submitted to the journal Frontiers in Environmental Science for inclusion in a special edition on "Climate Change Impacts on Water Resources". The paper will cover the climate analysis and key lessons learned. Full manuscript is pending.

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS SEPARATE ATTACHMENTS TO YOUR REPORT

- Overview slide depicting the overall project framework/approach/ results to date attached as "GEI-NOAA_SARP_Small_Water_Systems_2014-Final_Overview_Slide.pptx".

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION (IF APPLICABLE)

https://sites.google.com/site/climateanalysiswatersystems/

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES

Lessons Learned

Key observations and lessons learned by the project team while engaging stakeholders, assembling data, conducting climate change analysis, assessing vulnerabilities, and developing adaptation plans are summarized below.

Data Products and Accessibility

- Obtaining groundwater data remains a major challenge in small water systems. Even though the Lompoc Plains and Lompoc Upland basins are considered well-documented groundwater basins, well production data are only available as annual series. Aquifer characteristics data required for assessing changes in groundwater recharge are also not readily available.

- In addition to NOAA, many federal, state and local agencies and research institutions provide climate datasets. Even within the same agency, different versions of derived data products are often made public available. There are also climate variables obtained from different platforms, models and data processing techniques. Each such datasets has its own measurement intervals and period of record. The result is that numerous data sources and options are available for key climate variables such as precipitation and temperature. For small, resource-constrained water agencies, the task of researching and selecting suitable datasets to use in local climate change assessments can be a significant deterrent from conducting such analysis.

- The practice of disseminating data at the finest temporal resolution available at source can significantly increase the amount of time spent pre-processing climate for analysis. For example, groundwater balance was computed using annual data as well production data is only available annually. However, daily precipitation and temperature data had to be retrieved and processed to extract the annual variables required for the analysis.

- Many web portals for disseminating climate data are frequently redesigned to take advantage of changes in technology and data production organizations. The lack of stability in data dissemination services reduces the productivity of small agency users attempting to update climate analysis with data products they may have used in the past.

- To derive local climate indices, users are often required to download and process extensive primary datasets which have regional or even global coverage. After datasets have been processed, intensive computations involving multiple variables are often required to generate climate indices of interest. New climate services that more direct and reliable access to local primary and derived climate indices would significantly reduce the data processing burden on small water systems seeking to perform local climate change analysis.

Climate Change Analysis

- Climate change predictions though informative are often viewed as too uncertain to be used as a basis for making infrastructure investment decisions. Analysis of historical changes in climate and water variables is often more crucial to persuading water customers and managing boards about the need for action.

- Analyzing the length and completeness of historical records can help planners of small water systems to better understand the range of past climate states through which existing water infrastructure have been operated. This knowledge enables small system operators to put climate change predictions into the context of past operations.

- Small water systems have often been in existence for a shorter period of time than larger water system. Gauges from larger, regional water systems with longer periods of record should be compared with local gauges whenever possible. Such comparisons provide useful information about the nature of climate variation during past periods when no data is available for the small system.

- Datasets of different variables do not span similar time periods or time steps hindering their conjunctive usefulness in an analysis. For example, in the Lompoc area about 50-60 years of precipitation and temperature data are available but there is only about 30 years of concurrent groundwater data available for building the water balance model.

- Projections of precipitation from Global Climate Models (GCM) which show very different under various future emission scenarios can actually hinder climate adaptation planning in small water systems. For example, a small agency is more likely to defer an infrastructure decision if projections indicate that the possibility of either a 20 percent reduction or a 15 percent increase in annual precipitation. Technical guidance on how emission scenarios are evolving and scenarios are most appropriate to use for sector planning applications such as preparing small water systems.

- Relationships between climate teleconnection indices and local climate or water parameters should be examined to facilitate monitoring and adaptation to climate variability alongside climate change. Examples of teleconnection indices include the El Nino Southern Oscillation (ENSO), Madden Julien Oscillation (MJO) and the Pacific Decadal Oscillation (PDO). Web-based tools and data services are facilitate routine integration of climate variability indices with local climate and water parameters.

Infrastructure Vulnerability Assessment

- GCM data only provide pure climate variables such as temperature, precipitation, whereas most water infrastructure planning decisions require information about flow rates and capacities. Derived climate indices are required to bridge the information gap to transform climate predictions into decision making variables. Derived climate indices such as evapotranspiration and degree day indices should be routinely computed and distributed through targeted climate services that small water agencies can access for planning.

- Local water professionals and water users are the best source of information about infrastructure needs, past performances, problems encountered, and vulnerabilities in small water systems. Vulnerability assessments should be performed through participatory sessions where local experts can share their knowledge. Participatory sessions also provide opportunities for assumptions about future reliance to be tested and refined based on differing perspectives of the water system expressed.

- Many neighboring communities face infrastructure vulnerability concerns and resource management problems that are similar in nature. These communities are not completely aware of each other's issues due to lack of communication. Climate programs should encourage dialog and collaboration between neighboring communities to facilitate increased knowledge sharing and leveraging of efforts and resources to develop cost-effective solutions.

- Given the evolving nature of climate science, it is important for climate analysis and adaptation plans to be updated every few years. Climate information services which support such analysis would help communities to review and adapt their plans based on actual evolution of climate indices, scientific knowledge and the performance of existing infrastructure.

Stakeholder and Community Dynamics

- Small water agencies and the communities they serve have a strong interest in accessing results of climate studies beyond local impacts. Regional climate impacts which alter the viability of socio-economic activities and population distribution could eventually impact water demand and supply. For example, major population shifts could occur in the Lompoc Area if changes in fog regime impacts operations at Vandenberg Air Force Base, the largest local employer. Climate services should facilitate place-based search for results of other local or regional studies.

- The staff of local agencies is unlikely to include professionals with significant training or experience with climate change models and data as climate adaptation related functions are performed periodically rather than as sustained operations. Consequently, training programs that seek to establish such local climate analysis expertise are unlikely to be successful. National and regional efforts should be focused on online services that make it easier for small water systems to access derived climate information that is locally-relevant and directly-actionable.

- Communicating the importance of climate adaptation actions in regions where historical changes show no appreciable impacts is a difficult undertaking, even when climate projections indicate that future changes are likely. National and regional agencies should invest efforts in identifying areas where climate predictions are inconsistent with historical change and providing a strong rational for performing adaptation planning in such change regions.

- Some communities served by small water systems with perceive climate change as a controversial subject or may be too engaged in addressing more immediate challenges to actively participate in a public climate adaptation planning process. National and regional

agencies can still facilitate adaptation planning in such communities by making it easier for local water professionals to access climate impacts and integrate adaptation strategies into other existing activities and regulatory planning processes.